

CLAIMS

WHAT IS CLAIMED IS:

- 5 1. A stage device comprising:
a base;
a stage positioned adjacent to the base and movable relative to the base;
a bearing assembly comprising at least one fluid bearing interposed
between the base and the stage for supporting the stage on the base and movable
10 relative to the base and the stage.
2. The stage device of claim 1 further comprising a motor for moving the
stage relative to the base in at least one degree of freedom over a stroke of the
stage.
- 15 3. The stage device of claim 2 further comprising a motor operable to
move the bearing assembly relative to the stage and the base in a direction
generally the same as a direction of movement of the stage at a velocity
approximately one half of the velocity of the stage.
- 20 4. The stage device of claim 3 wherein the bearing motor has a lower
bandwidth than the stage motor.
5. The stage device of claim 2 wherein the base has a generally planar
25 surface, the bearing assembly being positioned for movement over said planar
surface, said surface having an X dimension approximately equal to the X
diameter of the bearing plus one half of the X stroke of the stage; and having a Y

dimension approximately equal to the Y diameter of the bearing plus one half of the Y stroke of the stage.

5 6. The stage device of claim 2 wherein the stage motor is operable to move the stage relative to the base in five additional degrees of freedom.

7. The stage device of claim 2 wherein the stage motor is a planar motor.

10 8. The stage device of claim 2 wherein the stage motor is a linear motor.

9. The stage device of claim 1 wherein the bearing assembly comprises a retaining member, said at least one fluid bearing being attached to the retaining member for movement therewith.

15 10. The stage device of claim 9 further comprising a motor for driving the retaining member in a direction generally following the direction of the stage.

20 11. The stage device of claim 10 further comprising a shaft having one end attached to the motor and the other end attached to the retaining member for moving the retaining member.

25 12. The stage device of claim 9 wherein the retaining member is a generally rectangular plate and said at least one fluid bearing comprises four bearings, each bearing being attached to a corner of the plate.

13. The stage device of claim 12 wherein the base comprises four base pads disposed on an upper surface of the base, and wherein the stage comprises

four stage pads disposed on a lower surface of the stage, each pad being positioned for receiving one of the bearings thereon for movement of the bearing between the base and stage.

5 14. The stage device of claim 1 wherein the fluid bearing is an air bearing.

15. The stage device of claim 1 wherein the bearing is preloaded.

10 16. The stage device of claim 15 wherein the preload is provided by a gravitational weight of the stage.

17. The stage device of claim 15 wherein the preload is provided by at least one spring attached between the stage and the base.

15 18. The stage device of claim 15 wherein the preload is provided by at least one bearing placed between the stage and the base.

20 19. The stage device of claim 15 wherein the bearing assembly incorporates a vacuum preloading mechanism.

25 20. The stage device of claim 19 wherein the fluid bearing comprises two bearing members, each including a port and a cavity, the port communicating with the cavity and connected to a vacuum pump such that the cavity can be evacuated through the port.

21. The stage device of claim 20 wherein each bearing member has an outer surface having a groove and an annular array of orifices within the groove, and a plenum that connects the orifices to a fluid inlet.

5 22. The stage device of claim 20 wherein each bearing member has an outer bellows and a channel connecting the cavities, the channel being isolated within the outer bellows by an inner bellows.

10 23. The stage device of claim 1 wherein the fluid bearing is operable in a vacuum.

15 24. The stage device of claim 1 wherein said at least one bearing comprises a plurality of bearings, each bearing being adjustable in a direction generally orthogonal to a plane of the base upon which the bearings slide.

20 25. The stage device of claim 24 wherein each bearing is generally cylindrical in shape and comprises a sidewall flexible in an axial direction to allow for adjustment of the height of the bearings.

25 26. The stage device of claim 24 wherein each bearing comprises a bellows.

 27. The stage device of claim 26 wherein each bearing comprises a port for providing fluid to the bellows to increase pressure within the bearing and increase the height of the bearing.

28. The stage device of claim 1 wherein the fluid bearing has two generally planar surfaces on each end thereof, one outer surface being angularly rotatable relative to the other surface to compensate for variations in planar surfaces of the base and stage over which the bearing slides.

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29. The stage device of claim 1 wherein the fluid bearing comprises two bearing members, each bearing member having an outer surface with an orifice for delivering fluid therefrom, and an inner surface, the two bearing members being positioned with the inner surfaces adjacent one another, and a flexible coupling connecting the two bearing members together to allow for angular rotation of each bearing member relative to the other bearing member to compensate for variations in planar surfaces of the base and stage over which the bearings slide.

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30. The stage device of claim 29 wherein the flexible coupling comprises a bearing interposed between the two bearing members and received within generally spherical recesses formed in the inner surfaces thereof.

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31. The stage device of claim 1 further comprising a platform extending from the base and movable relative thereto in a direction generally perpendicular to a planar surface of the base upon which the bearing moves.

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32. The stage device of claim 31 wherein the platform is movable about two axes forming a plane of the planar surface of the base.

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33. The stage device of claim 31 further comprising an actuation device operable to move the platform.

34. The stage device of claim 33 wherein the actuation device comprises a piezoelectric actuator.

5 35. The stage device of claim 33 wherein the actuation device comprises a hydraulic actuator.

10 36. The stage device of claim 33 wherein the actuation device comprises a piezoelectric actuator operable to make small changes in a position of the platform and a hydraulic actuator operable to make relatively large changes in a position of the platform.

15 37. The stage device of claim 33 further comprising a plurality of actuation devices independently controlled to provide movement of the platform about two axes forming a plane of the planar surface of the base upon which the bearing moves.

20 38. An exposure apparatus comprising:
a frame;
an optical system mounted on the frame;
a base;
a stage supported by the base and positioned adjacent thereto, the stage being movable relative to the base and the optical system; and
25 a bearing assembly comprising at least one fluid bearing interposed between the base and the stage for supporting the stage on the base and movable relative to the base and the stage.

39. The exposure apparatus of claim 38 further comprising a motor for moving the stage relative to the base in at least one degree of freedom over a stroke of the stage.

5 40. The exposure apparatus of claim 39 further comprising a motor operable to move the bearing assembly relative to the stage and the base in a direction generally the same as a direction of movement of the stage at a velocity approximately one half of the velocity of the stage.

10 41. The exposure apparatus of claim 38 wherein said at least one bearing comprises a plurality of bearings, each bearing being movable in a direction generally orthogonal to a plane of the base upon which the bearings slide.

15 42. The exposure apparatus of claim 38 further comprising a platform extending from the base and movable relative thereto in a direction generally perpendicular to a planar surface of the base upon which the bearing moves.

20 43. A method of positioning a stage within a lithography system having a base and an optical system for imaging a pattern onto an article supported by the stage, the stage being located adjacent to the base and movable relative thereto, the method comprising:

 placing a fluid bearing between the stage and the base, the bearing being movable relative to the base and the stage;

 moving the stage in a first direction; and

25 moving the bearing in the first direction.

44. The method of claim 43 wherein moving the bearing comprises moving the bearing at approximately half the velocity of the stage.

5 45. The method of claim 43 further comprising moving the stage and the bearing in a second direction generally perpendicular to said first direction.

46. The method of claim 45 further comprising moving the bearing in a third direction generally orthogonal to the first and second directions.

10 47. The method of claim 46 wherein moving the bearing in said third direction comprises pumping fluid into the bearing to expand bellows in the bearing.

15 48. The method of claim 45 further comprising moving a portion of the base in a direction generally orthogonal to said first and second directions.